[redacted]

General Conclusions

The Group has reached a number of general conclusions and recommendations regarding the nature of the program in the field of satellites and space flight which we feel the United States should undertake. They are as follows:

1. There should be a sound, well-coordinated National program leading into large satellites. It should not be limited in scope, but should cover all aspects of satellite and space flight. The Group recommends that at least 10% of the funding of such a program be devoted to relevant research and exploratory experimentation.

2. The first major step in the National program should exploit the impressive potentialities of the IRBM boosters, which would appear to be capable of satisfying most of the military satellite objectives even for the long term, as well as many of the initial problems of space flight. The Group recommends that a program emphasizing minimum vehicle development effort be initiated immediately, with concurrent planning for longer term exploitation, including improved high speed stages of the IRBM vehicles.

3. The larger ICBM's will make it possible to carry out elaborate military and other missions, including many studies in space medicine. WS-117L is an initial effort in this direction and the Group supports its continuation, but recommends that the National program include alternative efforts toward the full development of the ICBM potentials for both military and non-military applications.

4. In all phases of the National program the military and scientific needs should be organized so as to be mutually reinforcing; and the Group recommends that vehicles be specifically allocated as needed for the various military and scientific uses. Details of such allocations should be determined by the Department of Defense in consultation with the National Academy of Sciences, and the National Science Foundation.

The Group also makes the following more specific comments and recommendations:

1. All three of the military services have stated their support of a national satellite and space flight program serving both military and scientific needs.

2. All three of the military services have stated that the highest priority military requirements for satellites are for reconnaissance and surveillance. Other common military requirements exist for satellites as aids to navigation, in communications, and for weather data collection (see Table II).

3. All three military services presented short-term programs using an IRBM booster capable of launching 300 to 500-pound satellites on about 200-mile orbits. From the technical standpoint the Group considers both JUPITER and THOR equivalent for these purposes when they have been developed to the point where they are sufficiently reliable.

4. Specific reconnaissance methods for the 300 to 500-pound satellites included an Air Force proposal using film recovery techniques and an Army proposal for television type reconnaissance. The latter could be tested in a 100-pound satellite which might be available sooner. The Group recommends testing of both of these techniques as the highest priority portion of the immediate program. A fractional allocation of potential vehicles in the short-term program should also be made for scientific test purposes other military requirements and space exploration. The scale of the program should aim toward a launching capacity of at least one a month in 1959. It appears that a great expansion of this rate will be required as soon as feasible, and coordinated military planning is therefore urgently required.

5. Orbits of higher inclination than those possible at Patrick Air Force Base, Florida (which is limited to orbits of between 28 and 45 degrees inclination) are essential for military applications and will require launching sites which will make it possible to launch satellites into polar orbits. Camp Cooke is one such site. The additional site and facility requirements at Patrick, Cooke and possible elsewhere for the rapidly expanding program must be determined and implemented simultaneously. The Group recommends that, as one of the first steps in any enlarged satellite program, steps be taken to activate Camp Cooke or equivalent sites suitable for polar orbit launchings immediately.

6. The inventory of national resources in rocket systems capable of orbiting useful payloads now or within the next several years include the VANGUARD, JUPITER "C", JUPITER, THOR, ATLAS and TITAN. The larger of these boosters will be coming into maturity about two years hence and should provide a capability of orbiting useful payloads up to about 3,000 pounds at 300 miles altitude and escape velocity applications for smaller payloads. Larger payloads will require that an intensive research and development effort be directed toward considerabley larger propulsion units or high-energy propellants, preferably both. Propulsion component development for maximum capability should be focused on high-capacity turbo-pumps and combustion chambers toward an objective of attaining a propulsion capability of 1 million pounds thrust or greater, in a single unit. The Group recommends that a formal program leading to high thrust rocket engines be initiated. The Group also recommends increased support for research and engineering developments with high-energy propellants, storable propellants, and the other basic technological fields contributing to high performance rocket applications. An increased effort on the development of highly reliable, long-lived components will be of high significance in determining the overall utility of satellites.

7. Unmanned (instrumented) explorations of the moon, Venus and Mars appear to be feasible within the capabilities of chemical propellants and presently planned systems. Preliminary lunar tests could be performed within the capabity of the IRBM systems and should be included in the early part of that program.

8. Manned exploration of the moon, Mars, and Venus may ultimately be feasible within the capability of chemical propellant systems.

9. The X-15 project represents the most advanced current project leading in the direction of manned space flight. While the Group did not formally review the X-15 project, it observes that any manned space flight program should draw on the experience of the X-15 program.

10. A preliminary presentation of the problem on anti-satellite missiles was presented to the Group by the Navy. The Group feels that this subject is in urgent need of further study by the military services.

11. The Navy also presented some consideration of the possibility of airborne satellite launching. While the Group does not necessarily indorse this approach, a more complete study leading to clarification of this question would be desirable.

II DISCUSSION

General

The Group's first general conclusion is a logical corollary of the 4 points which it accepted at the outset, and which have been supported by all of the presentations of the Military Departments. The Nation needs a sound, well-coordinated, and firmly conducted program leading to large satellites and manned space flight.

The National interests require that certain devices be placed in operation at the earliest possible date. The Group has tried to show in this report how the most useful of these devices for both military and scientific purposes can be realized at the earliest practicable dates.

The urgency of these projects has dictated the maximum possible use of existing equipment, particularly the large engines and other components. However, the Group emphasizes that in a field as new as the one here considered it is impossible to specify in detail the best possible long-range programs. For this reason, great emphasis must be placed on relevant research and experimentation of an exploratory nature. The Group therefore recommends that not less than 10 percent of available funds of the National program be devoted to these purposes.

The second general conclusion, and the one upon which the greatest emphasis should be placed, calls for immediate action to take advantage of the impressive potentialities of the IRBM boosters. If the decision on this point is promptly made, either THOR or JUPITER could be used to place 300 to 400-pound satellites on polar orbits at 200 nautical miles altitude by early 1959. Moreover, such a payload capability would satisfy the most urgent of the military satellite requirements in the reconnaissance and surveillance categories, and with some development might take care of many of the stated military requirements for some time to come.

The IRBM boosters are now well advanced in flight tests and should attain a degree of reliability adequate for satellite applications at least a year or more before equivalent status is reached with the ICBM. A 300 to 400-pound satellite payload seems to be about the minimum that would accommodate the desired military applications with adequate lifetime to accomplish the objectives. Such a payload capability would also accommodate many of the necessary tests preliminary to manned space flight. Moreover, some of the recent studies confirm the practicability of extending the satellite payload capability of the IRBM booster to at least a thousand pounds by 1960. One study concludes that the IRBM booster could probably launch a modified WS-117L vehicle during 1959 and advocates a program merging this interim effort with the longer term ATLAS-117L program with accompanying advantages in the latter development. The Group, therefore attaches the greatest importance to immediate action in support of using the earliest available IRBM's boosters because such a program has the best promise of yielding earliest results with relatively simple satellites for reconnaissance, and has also significant promise of longer term benefits.

The third general conclusion supports the continuation of the WS-117L program, and recommends simultaneous and complementary application of this vehicle system to both military and non-military uses. The more elaborate military missions require development of the maximum satellite payload capability, higher altitude orbits, more precise stabilization and control of the satellite, and longer useful life with attendant increases in power and other payload increases. The more elaborate scientific experiments impose similar requirements on the satellite vehicle. The ICBM boosters, the largest presently entering test, have the greatest potential for both military and non-military uses as the second step in the National program. These vehicles will be required as soon as available for advanced military applications, instrumented soft landings on the moon, tests with large animals, and other tests and experiments leading to space flight. Up to the present, significant development of the more elaborate satellite systems has been confined to very limited support of the WS-117L project; and the development phases of this project have emphasized the [reconnaissance-surveillance aspects] of military applications. The potentialities of WS-117L for other important applications are also greater in such things as communications, weather forecasting, and the many fields of pure science that would require an accurately stabilized and controlled satellite vehicle. It is, therefore, clear that the National program must, while placing the highest immediate priority upon satellites devised from IRBM boosters, also avoid stifling any satellite development that could fully exploit the next largest capability which will be available with the ICBM boosters. Not to recognize this advanced need and support it now could well bring on heavy penalties later. Early and effective support of the more elaborate satellite systems is necessary now if they are to be ready when the booster capability to launch them is realized.

For these reasons the Group recommends that the National program include alternative efforts leading to the development of satellite payloads for military and non-military applications which could exploit the full potential of the ICBM.

The fourth general conclusion recognizes the mutually reinforcing aspects of the military and scientific parts of the program. Advanced military developments depend upon advances in science.

The military necessity for intensive support of science particularly in this field is axiomatic. At the same time the pace of the engineering development of the basic boosters will be set primarily by military necessity. They require extensive and expensive ground launching installations; range or safety patrols and precautions; and they are beset by many hazards in handling. But it would be wrong to let the more obvious and immediate military necessities overshadow the equally vital military dependence upon longer term scientific observations or discoveries that can be provided by timely action. The proper action here, in the view of the Group, is to make specific allocations of satellite vehicles for both military and scientific uses. Details of such allocations should be determined by the Department of Defense drawing upon the experience and assistance of the National Academy of Sciences and the National Science Foundation, and the Group so recommends.

The Group has made a number of more specific comments and recommendations in amplification of the general conclusions discussed in the foregoing paragraphs. Most of these specific observations are self-explanatory in their summary form.

Among the specific recommendations the highest priority is placed on the earliest possible development of a military satellite of the 300-pound class which now seems to have promise of obtaining pictorial information of the USSR possibly within one year. Such a satellite may well give highly valuable and timely military information that could be obtained by no other foreseeable means within that period. Two schemas were described to the Group, one is basically photographic and offers the chance of recovering photographic film; the other is basically a spot-scan television technique with radio transmission to earth.

The Group recommends testing of both of these techniques as the highest priority of the immediate program.

For all of the military applications and for most of the scientific or commercial uses of satellites a launching site from which satellites can be placed on polar orbits is necessary. An orbit with inclination less than the latitude of the launching site is possible, but it is impracticable with existing techniques. On the other hand, it is possible to launch satellites on any orbits with inclination greater than the latitude of the launch site. However, the ground hazards from discarded rocket stages severely restrict the geographic sites that can be used. Mobile launching facilities are also similarly restricted, but not to the same degree as large fixed base installations. As to military vulnerability of launching sites, the same considerations would seem to be in order as apply to large military missile launching sites.

The rocket systems either now available, well advanced in development or currently planned that could be adapted to satellite launchers or space missions include a very wide variety of attractive combinations from the smallest like VANGUARD and JUNO I (formerly called JUPITER "C") with satellite payload of about 20 pounds at 200 miles altitude to an improved TITAN supplemented by additional stages which should be capable of orbiting in excess of 10,000 pounds at 200 miles.

There are many ways to appraise this rich assortment of possibilities. The Group has, however, considered first the propulsion and guidance performance of the assortment, for upon these 2 parameters mainly depend a satellite's orbital characteristics, the useful weights that it can carry, and its lifetime.

Secondly, the Group has accepted the statements of the military services on required applications, considered the methods proposed by the Military Departments for meeting their needs, and has attempted to show what can best be done, when it might be done with what is available, and what appears will be most needed in the future.

Military Applications of Satellites

(Table II)

The military applications given in Table II have been assembled by the Group in the order of priority in which the statements of the Military Departments would seem to place them.

All military services put the reconnaissance-surveillance applications at the top of the list. Within this general category there is some difference in priority of the sub-items depending upon the primary service mission. But the urgent need for intelligence data of the Soviet Union at the earliest date that seem possible with satellite techniques was stressed by all.

Many of the other military applications, particularly weather forecasts, communications, and navigation will sometimes, though not always, be possible with the same satellite used for surveillance. This is also true for many of the science applications. The feasibility of accomplishing satellite-countermeasure techniques by satellites is not as clear as the use of satellites for countermeasures against detection systems for ballistic missiles or other satellites.

A point stressed by the Navy in support of countermeasures against satellites deserves emphasis here: If the USSR develops a satellite surveillance system, they will have attained the means, which they have never before enjoyed, for keeping continuous plots of surface vessels in all oceans, and thereby make even more formidable their large submarine fleet.

Armed space patrol applications are so dependent upon experience yet to be gained in high performance propulsion systems, space medicine, and so on that little can be said about their potentials now except to recognize their ultimate possibility.

On the basis of the presentations by the Military Departments the Group is satisfied that a number of the proposed military applications of satellites have now been demonstrated to be sufficiently practicable to warrant immediate and substantial support by the Department of Defense. The Group's conclusions and recommendations are believed to represent in general terms the support it has given to the broad point of military uses. But the justification for a National program of the magnitude indicated requires a considerably broader view. It is necessary to look beyond the immediate or direct military applications in the conventional or traditional usage of the term.

The strongest point made by the Military Departments in support of direct military use is surveillance; but in a condition of declared war, for example, between the USSR and the United States, the Group has some reservations on the value of satellites for some types of surveillance, because under such conditions the question of "overt acts" would have been determined and other methods requiring overflight could be used.

Satellite reconnaissance or surveillance seems therefore attractive in the present epoch because this technique offers some promise of getting important and timely intelligence on the USSR with minimum political risks, but also because it could be used as a forceful political weapon in revealing to the world by photographs of the Soviet Union many things that are now effectively kept secret. Such employment would incidentally go far toward recovery of National prestige or technological leadership which has suffered momentarily.

Most of the other military applications have great potential non-military value, particulary as tools for science, weather forecasting, and communications.

However speculative the success of some of the military proposals may now seem to be, the Group is convinced that there is more than adequate justification for a program of the magnitude indicated.

When all of these points are conservatively weighed, the conclusion cannot be escaped that any National space program must be substantial, must be immediately authorized, and must be firmly directed. Any half-hearted or diluted effort will not do.

To indicate some idea of the magnitude of a National program such as the Group has in mind it can be said that the opinions of individual members of the Group fall between [redacted] for a three-year period for the overall National expenditure.

SUMMARY OF MILITARY APPLICATIONS
Stated by Military Departments

	Army	Navy	Air Force
Surveillance, Reconnaissance, Mapping			
Photographic, high resolution (20 ft.)	x	x	x
Low resolution (100 ft.)	x	x	x
(Targets, damage, post strike analy.)			
Early warning against attack	x	x	x
Electronic emissions (Ferret type)	x	x	x
Ships and aircraft plots	x	x	x
Submarine detection via sono buoys		x	
Communications (High frequency broad band relays, Electronic countermeasures, monitoring)	x	x	x
Weather and forecasts (Worldwide cloud cover, systems status, accurate forecasts)	x	x	x
Navigation (all weather)		x	x
Satellite countermeasures	x	x	x
Science directed toward military applications (Magnetic field for commun., atmospheric, thermal, solar radiation, for weather research; ionospheric observations; space biology, meteorite distribution; anti-missile research; air density)	x	x	x
Armed space patrol	x	x	x

BRIEF SUMMARY OF ARMY, NAVY AND AIR FORCE PROPOSALS

While differing in details the Army, Navy, and Air Force advocate a coordinated and comprehensive National program leading to manned space vehicles. Their presentations were based upon voluminous engineering and scientific studies which were made available to the Group, and copies of which are on file in the Office of the Secretary of Defense, Director of Guided Missiles.

All three services recognize the need for the integration of the scientific and military elements of the National program that will reduce the risks of dilution of National effort and resources and enhance the prospects of early recovery of American leadership in space technology and exploration.

Army Program

The Army proposes "A National Integrated Missile and Space Vehicle Develop- ment Program" for 14 years extending through 1971, and estimated to cost in the order of 14 billion dollars total.

The early phases of the Army program covering the first 3 years is a 16-vehicle program based upon the JUPITER missile as first stage booster, supple- mented by spinning clusters of rockets. The estimated cost of this part of the program for the 3-year period is about $440 million. It includes the 20-pound experimental reconnaissance satellite by June or September 1958, and a 500-pound satellite by January 1959. The Army estimates a capability for a 15-pound lunar shot by June or September 1958 and a 120-pound lunar shot with lunar photographs ty January 1959. Their estimate of a capability for lunar impact with a 50 to 100 pounds is sometimein 1959. The longer term parts of the Army's suggested program include manned carriers and would require more powerful boosters like TITAN with various combinations of high-speed stages as do all other proposals.

Navy Program

The Navy stresses relatively light vehicles for the short range part of the program. In their view most of the immediate military requirements can be fulfilled with payloads of 300 pounds or less.

While likewise proposing an extensive National program for satellites and space vehicles, based upon booster rockets, the Navy also attaches considerable importance to the X-15 vehicle approach as possibly the earliest method of ob- taining manned earth-orbiting vehicles; and they estimate that it might be achieved within 3 years. The Navy also advocates that more attention be given to engineering developments using even lighter launch mechanisms and include within their program 17 vehicles suggested by the Naval Ordnance Test Station for orbiting 10-pound satellites. They also recommend concurrent development of the "fly-up" method in addition to the rocket launch development.

As the short range part of the program through 1961, the Navy proposes a 50-vehicle schedule including satellites ranging from 10 pounds to 300 pounds, an anti-satellite demonstration, and a fly-up launch demonstration, for a total estimated cost [redacted] They also propose as inclusions in this schedule 5 lunar shots and a first manned orbital flight with the X-15 technique, but cost estimates are not yet available.

The 40 to 300 pound satellites of the Navy program would be launched by improved VANGUARD vehicles for the smaller, and a combination of THOR and VANGUARD components for the larger satellites.

As the first part of a longer-range program the Navy proposes four 1500-pound satellites using TITAN-VANGUARD combinations. Cost estimates for this part of the program are not yet available.

Air Force Program

The Air Force program emphasizes the largest, most elaborate satellites and space vehicles which are based upon the ATLAS and TITAN missiles. But they also suggest the possibility of a 300-pound recoverable photographic satellite using the THOR booster for availability during 1959.

The Air Force Advanced Reconnaissance System, WS-117L, has been under intensive study since about 1951, although studies of feasibility were begun in 1946. The objectives of this program include photographs expected to give an ultimate resolution of 17 feet, ferret detection and location of various high frequency emissions (up to 18,000 megacycles) with initial accuracy of 60 miles and increasing precision later, infrared surveillance of aircraft and ICBM's, and ultimate visual surveillance with television techniques of ½ mile or better.

Under an accellerated program the Air Force estimates that the first of test vehicles of this program could be ready during 1959 for launching 2,000-pound satellites at 300 mile altitudes. Including costs already incurred, this program would probably cost about 200 million through 1959, but the Group is not clear on Air Force cost estimates.

The Air Force estimate of a recoverable photographic satellite for use with THOR is about $20 million in addition to the cost of the boosters. Reliable estimates of costs for longer term elements of the Air Force suggestions are not available.

The studies and development to date on WS-117L cover almost every phase of the reconnaissance satellite problem, including nuclear power, radio isotope reactor power, solar cells and their possible applications. The studies also go far into the accompanying ground tracking and communication facilities.